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LIFE-DEEP Learning

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contents

The Redesigning Pedagogy International Conference—National Institute of Education's flagship conference—will be taking place on 30 May to 1 June 2022. The theme of the upcoming conference will be on "Transforming Education and Strengthening Society", focusing on how education can be even more transformative in line with the new and rapid local and global developments. Find out more about the conference at **https://rebrand.ly/RPICwebsite**.

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Dr David Huang

Senior Education Research Scientist
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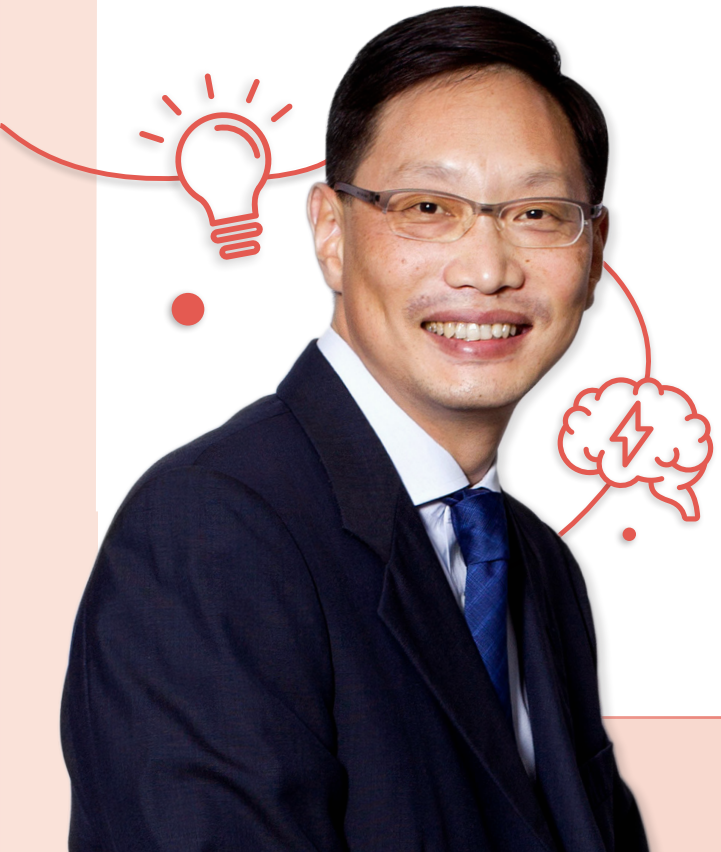
As educators, we always wonder what kinds of learners we should develop in order for them to excel in a volatile, uncertain, complex and ambiguous (VUCA) future. Since the future is unknown to teachers now, it is impossible for teachers to teach students all the knowledge and skills they need in the future. So, what can teachers do to prepare for future-ready learners?

To respond to this challenge, a Four-Life Learning Model was proposed by NIE in 2017 to encapsulate learning for the future. The model recognizes four forms of learning, namely life-deep, life-wide, life-long and life-wise learning. Life-deep learning is about developing deep content knowledge in domain subjects; life-wide learning involves learning and transfer across formal and informal contexts with interdisciplinary understandings; life-long learning connects learning with purpose for continuous knowledge and skills development throughout one's lifespan; and life-wise learning involves the development of values, morals, characters, well-being and practical wisdom in life.



The Four-Life Learning Model is well connected to MOE initiatives. For example, to foster the joy of learning, we need to build life-long learning dispositions, distill life-deep expertise and promote life-wide interests. Entrepreneurial dare is about leveraging life-deep expertise and content mastery while, at the same time, engaging life-wide learning for boundary crossing between formal and informal contexts and multiple disciplines, in order to effectively think outside of the box.

What needs to be further unpacked are the relationships among the four forms of learning. Are they referring to four different types of learning that have respective unique development trajectories, or are they the characterization of learning from four different lenses? In schools, there is a long tradition focusing on deep content mastery. Have we sufficiently helped students for life-deep learning? How would the other three forms of learning contribute to life-deep learning and vice versa?

Taking on these questions, this issue of *SingTeach* explores life-deep learning by underscoring the development of adaptive expertise which is to balance efficiency in applying knowledge and innovation in creating novel knowledge and solutions. Conceptual understanding, procedural knowledge and procedural flexibility contribute to the development of adaptive expertise. While recognizing that Singapore schools are adept at developing students' procedural knowledge and have also increasingly focused on developing students' conceptual understanding, this issue highlights the importance of developing procedural flexibility and suggests a few ways of doing so.

In addition, the issue also articulates the developments of the four forms of learning to be both the means and ends for each other: the development of life-deep learning contributes to the other three types of learning and vice versa. Together, they contribute to the optimal development of future-ready learners.

Scan the QR code for more information on the Four-Life Learning Model.

A LIFE-LONG PROCESS OF

Purposeful Learning

How can we better prepare our students to be future-ready learners? One of the ways we can empower our young minds to face a future fraught with new challenges is by recalibrating our focus on the meaning of purposeful learning. It encompasses these four forms of learning—life-long, life-deep, life-wide and life-wise. The Guest Editor of this *SingTeach* issue, Dr David Huang, a Senior Education Research Scientist at the Centre for Research in Pedagogy and Practice at NIE, shares more about four-life learning and the importance of deep learning.

What is Four-Life Learning?

While the four forms of learning—life-long, life-deep, life-wide and life-wise—focus on the different aspects of learning, they do not exist in isolation as their developments are interrelated.

Giving an example, Dr David Huang, who is also Associate Dean of the Office of Education Research (OER) at NIE, explains: "When students draw on their (formal) classroom experience and (informal) everyday experience, they also develop a deep mastery of knowledge. Being able to link the formal and informal experience together in learning contributes to both life-wide and life-deep learning."

Life-wide learning, he explains, is about learning and transfer across multiple contexts. The process of learning extends beyond the parameters of school as it occurs in informal learning environments as well. Life-deep learning, meanwhile, is about having a deep understanding of disciplinary content and involves the development of adaptive expertise. As articulated by Hatano and Inagaki (1986), adaptive expertise seeks to achieve both efficiency and innovation.

Expanding more on the interrelatedness of the four types of learning, he says: "Learning is a continuous developmental process as it occurs across one's lifespan, from infancy to adulthood. Life-long learning contributes to life-deep learning. At the same time, life-deep learning also acts as a stepping stone for future learning."

He points out that in the dual processes life-deep learning contributes to the other three types of learning and vice versa. This suggests that the four types of learning are both the means and ends for each other.

More than Just Routine Expertise

Life-deep learning, says David, is of particular importance to him. "Life-deep learning is about developing adaptive expertise, rather than routine expertise. To develop adaptive expertise, students need to explore new learning opportunities that balance efficiency and innovation," he says.

He is encouraged to see schools investing in helping students develop life-deep learning, particularly in strong procedural knowledge which refers to how one does something, such as solving a word problem. While there is a concerted effort in strengthening procedural knowledge, he points out that sustaining this strength is not enough.

"Children who receive nothing but efficiency-oriented instruction may well be adequate in solving routine problems, but limited in dealing with an uncertain future," he reiterates.

The necessary ingredients of life-deep learning, he adds, also include *procedural flexibilities* and *conceptual understanding*.

The Role of Conceptual Understanding

Conceptual understanding refers to understanding the principles and relationships that underlie a domain. It plays an important role, for example in problem solving, as it increases the ability for flexibility and adaptability, and provides a criterion to select for alternative possibilities for each step of a solution method.

"The direct application of prior knowledge can hardly give rise to learning new concepts," he says. "As such, developing conceptual knowledge requires a different kind of interaction."

He acknowledges that while it may be simpler and more efficient for schools and school leaders to build resources that can help students learn how

to solve simple problems in academic settings, efficiency-driven instruction may not do justice to developing student innovation or optimizing their potentials.

"Fortunately, I do see schools paying more attention in helping students develop conceptual understanding. For example, I have observed schools using props combined with self-explanation prompts to help students develop their conceptual understanding in a particular subject and increase their potential for adaptability and transfer," he shares.

Developing Students' Procedural Flexibility

"Besides continuing the good practices in developing students' procedural knowledge and conceptual understanding, my research suggests a need for schools to develop students' procedural flexibility as well," he says.

Professor Jon Star, an educational psychologist from Harvard University, refers to procedural flexibility as learners knowing multiple procedures to solve a range of problems and being able to choose the best procedure for a particular problem.

David brings up an example of helping students judge whether an integer is divisible by three. "One efficient procedural solution is to sum the digits of the integer and check whether the sum is divisible by three," he notes.

In contrast, to help students develop procedural flexibility, he suggests that a teacher can first encourage students to come up with as many different methods as possible. Next, the teacher can engage the students in evaluating these methods, choosing the most efficient solutions and justifying their choice.

"By implementing this teaching approach, students can develop both conceptual understanding and procedural flexibility," he adds.

Nurturing Future-Ready Life-Long Learners

David emphasizes that the purpose of learning should not be limited to the mastery of knowledge (life-deep learning). It should involve guiding students to deal with future transfer tasks (life-long learning) that may be in formal or informal settings (life-wide learning) and may also involve the development and transfer of big ideas or principles such as values, morals, character and historical empathy (life-wise learning).

"Developing all the four forms of learning focuses on constant development (i.e., learn for life) and adaptability. In doing so, we are preparing future-ready learners for an uncertain future," he affirms. ▮

Reference

Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. W. Stevenson, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262–272). W H Freeman/Times Books/ Henry Holt & Co.

ABOUT THE INTERVIEWEE

David Huang is Senior Education Research Scientist at the Centre for Research in Pedagogy and Practice, Office of Education Research (OER) at NIE. He is also Associate Dean, Research Administration and Support of OER. His research interests include transfer of learning, design thinking and innovation and research management.

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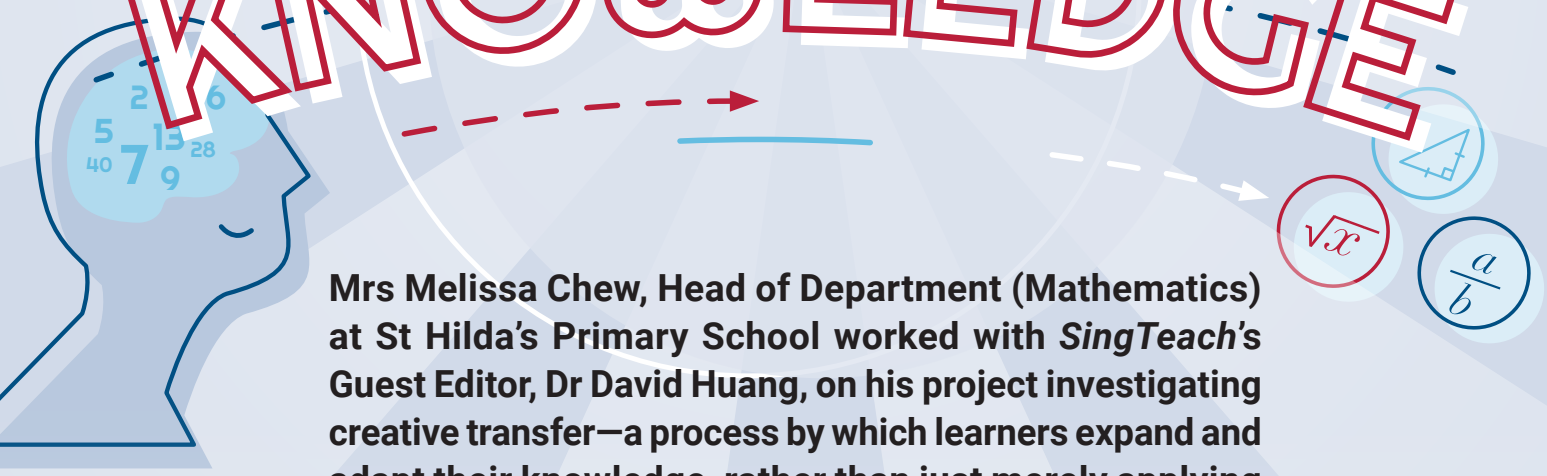
THE TRANSFER OF KNOWLEDGE



Mrs Melissa Chew, Head of Department (Mathematics) at St Hilda's Primary School worked with *SingTeach*'s Guest Editor, Dr David Huang, on his project investigating creative transfer—a process by which learners expand and adapt their knowledge, rather than just merely applying existing knowledge in near and far contexts. She shares how the experience was, the lessons she has learned and how she has applied this in her classroom practice.

What is Creative Transfer?

"I participated in Dr Huang's pilot study for his project researching creative transfer in 2019," Mrs Melissa Chew, Head of Department (Mathematics) from St Hilda's Primary School, shares. "A few teachers and I collaborated with Dr Huang's team on his initial project study which involved trying out the tasks prepared by the research team, analysing students' responses and helping improve the tasks for the main study. This is how I discovered the creative transfer approach in developing knowledge."

Transfer, she explains, occurs when a learner applies knowledge or skills learned in one context to a different context. As this signals that the learner's level of comprehension is high enough that they are able to recognize how their knowledge or skill can be relevant outside of its original learning conditions, transfer is often considered as a sign of true learning. Creative transfer, where learners adapt their knowledge in transfer, is thus regarded as the highest level of transfer.

Overcoming Challenges

"Even though we experienced some bumps in the road during the research study, we persevered and it has been a rewarding experience thus far," Melissa remarks.

"The first issue we had to overcome was finding a time slot for our students to complete the tasks assigned during the study. Thus, we scheduled these exercises to be conducted after the semestral assessments as a post-examination activity."

Another challenge faced was that in order to encourage creative transfer, teachers would need to model metacognitive strategies effectively for students to follow. To do so, teachers needed to first understand the meaning of metacognition—thinking about thinking—in order to devise a lesson strategy.

"Creative transfer and metacognition are interrelated," Melissa notes. "Metacognition is an individual's ability to be aware of the need to monitor and regulate their own thinking, and any transfer task must be linked to already existing knowledge."

She emphasizes that when students are aware of their thought process, it becomes easier for them to discover what they already know, and how to adapt that to different situations.

Solving Word Problems through Metacognition

"In brainstorming how to model the use of metacognitive strategies in solving a word problem, my colleagues and I concluded that we should share our thought process aloud to the students," Melissa shares. "After reading the word problem aloud to the class, we described our process of understanding what the problem is asking us to solve for."

"While formulating a plan to solve the word problem," she continues, "we also shared with the class on what we could use to solve the problem, such as previously learned strategies. We would then have to decide if there was a need to abort, change or stick to the chosen plan in order to solve the question." Through this process of thinking aloud, teachers are thus modelling the use of metacognitive strategies in effective problem-solving.

After the teacher's demonstration, students were given their own word problems and were reminded of the resources available to them while tackling the problem—ranging from previously learned strategies to help from more capable friends or their teachers.

While students worked through their plan of how to approach the problem, the teachers guided them through the process of questioning themselves and their thinking as a way to monitor and regulate their progress. As the students synthesized what they learned, they were able to generate new ideas from existing knowledge—or, in other words, embark on creative transfer.

Life-Deep Learning

According to Melissa, working on the project with Dr Huang has taught her a great deal about life-deep learning. "My team and I continue to encourage our students to build a habit of reflecting on their own thinking. When students engage in metacognitive thinking, they are constantly thinking about what they are doing and deciding on the best plan to complete any task that is assigned to them."

She also points out that when students learn how to carry out the process of creative transfer, they may acquire a deep and long-term mastery of the subject.

"Furthermore, when students learn how to develop, expand and adapt their knowledge, they discover that their knowledge and skills are actually applicable in many different contexts. This is one of the ways on how we can nurture our young minds to engage in life-long and life-deep learning, and prepare them to thrive in an increasingly complex world," she says. ▮

ABOUT THE INTERVIEWEE

Melissa Chew is Head of Department (Mathematics) at St Hilda's Primary School. In 2019, she worked with NIE Senior Education Research Scientist Dr David Huang on his pilot study for his project on creative transfer.

RETHINKING LEARNING FROM Creative Transfer

How do we define learning in the 21st century? According to NIE Senior Education Research Scientist Dr David Huang, learning should not only involve the ability to acquire knowledge efficiently, but also be able to innovatively transfer the newly acquired knowledge beyond specific contexts and instances, a process called "creative transfer". In this article, he shares more about his research project that focuses on creative transfer in Math.

Creative transfer occurs when students synthesize, expand, combine and adapt their knowledge in transfer so as to create novel concepts and procedures. "An example of creative transfer is a student creating a solution method for a question in a curriculum topic they have never learned before," says Dr David Huang.

His research project consists of two sub-studies, the first of which (Study 1) was conducted on primary school students across three local schools. Study 1, he explains, explores the extent to which the learners' domain knowledge of the already-learned topics of fraction multiplication and whole number division can influence their creative transfer to the untaught topic of fraction division.

"In Study 1, we found that *procedural flexibility* and *conceptual knowledge* are particularly important for transfer to take place," he notes.

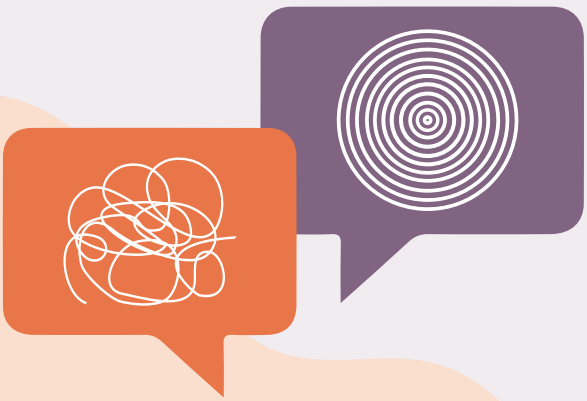
Discovering Learners' Potential for Creative Transfer

In the initial stages of the study, the research team found that there were a number of students who already had prior exposure to fraction division before it was introduced in the formal curriculum.

"After realizing this situation, we took the opportunity to compare creative transfer (by students who had no prior exposure to fraction division) versus application of knowledge in usual transfer (by students who had prior exposure)," he explains.

The direct comparison between the two groups of students led to the finding that *procedural flexibility* of (previously learnt) whole number division and fraction multiplication was particularly important for those students who had prior exposure to fraction division. Meanwhile, for those who did not have prior exposure, their conceptual knowledge of whole number division and fraction multiplication was important for them to invent their own methods in solving fraction division problems.

"Teachers and researchers were also pleasantly surprised to note that students developed many novel creative transfer approaches to solve fraction division problems, suggesting that students in Singapore have good potentials in creative transfer," he shares.



Further Implications of the Study

The research project has important implications on how teachers can change their approach in teaching new topics and at the same time, foster deep learning in the classroom.

David shares that the research team has given feedback to teachers that students had difficulties in answering conceptual questions, for example drawing models to illustrate and explain mathematical relationships.

"Based on our observations, many students answered the questions by providing procedural steps instead," he states. "This suggests a need for developing students' *conceptual knowledge,* as well as strengthening the disciplinary language in explaining concepts and mathematical relationships."

Furthermore, the study has shown that students who do not have prior exposure to fraction division have used their prior conceptual knowledge on whole number division and fraction multiplication to solve novel problems on fraction division.

Thus, this implies that having procedural knowledge, while necessary, is not sufficient. "A deep conceptual understanding of a topic would not only help students learn the topic well, but also prepare them to use the conceptual understanding to deal with new curriculum topics later on," he explains.

Meanwhile, for students who already had prior exposure to fraction division, their procedural flexibility of whole number division and fraction multiplication predicts their transfer in solving fraction division problems.

"To strengthen students' procedural flexibility, teachers can encourage them to solve problems using as many methods as possible, even if some methods are not as efficient," he shares. "This flexibility could help students integrate the old curriculum topics they had learned before with new topics they are currently learning."

Enhancing Our Understanding of Creative Transfer

David shares that Study 2 will be rolled out in May 2022.

"Study 1 has provided us with an understanding on the different forms of domain knowledge that can influence creative transfer in learners," he says.

"Study 2, meanwhile, seeks to examine 'compare and contrast' as a pedagogy in developing students' domain knowledge. It also looks at whether improving domain knowledge of already learned curriculum topics increases students' performance in creative transfer."

The creative transfer of knowledge, he emphasizes, should be an essential feature in education. The payoff for meaningful instruction lies in not just an immediate retention of the learned information, but also in transfer to novel situations in future.

"As future novel situations may not be known to the present teachers and learners, students need to be capable of dealing with transfer tasks that teachers cannot (or do not) directly prepare them for," he adds. "Hence, developing students' ability for creative transfer empowers them to be the future pillars of tomorrow."

ABOUT THE INTERVIEWEE

David Huang is Senior Education Research Scientist at the Centre for Research in Pedagogy and Practice, Office of Education Research (OER) at NIE. He is also Associate Dean, Research Administration and Support of OER. His research interests include transfer of learning, design thinking and innovation and research management.

Finding Meaning in Learning

In recent years, there has been growing interest in the concept of deep learning to draw out students' full potential. How can we create meaningful learning experiences for our students and equip them with the necessary skill sets to adapt to changes of the future? Two Master Teachers discuss how they instill deep learning in their students in a classroom setting.

Dr Foo Kum Fong
Master Teacher (Secondary Mathematics)
Serangoon Secondary School

How can we help students to develop the desired skill sets and dispositions necessary for deep learning?

Deep learning encompasses the following:

- content mastery for the joy of learning
- acquisition of the trait of life-long learning
- proficiency in critical thinking and problem solving

To help students develop these skill sets, we need to first empower them as self-directed, "unfettered" learners—the latter meaning that students can learn anytime and anywhere with the use of technology. During my teaching stint, I have developed a series of instructive video clips related to the current lessons and uploaded them onto a *Google* site for easy access and retrieval. Some may argue that such a mode of learning is not suited for all students, but I do not agree. During the June holidays last year, I received a text message from a Normal Technical student enquiring about a Math problem. Initially, I had tried my best to explain to him in a written note, but he was confused by the text-heavy written explanation. I then made a succinct explanatory video (which was subsequently uploaded onto a self-learning website for unfettered, continuous access) which demonstrated the solution to the Math problem. He found it clear and helpful and could even access it as many times as he wished. Some of his classmates followed suit when they heard about it. We should believe that no student chooses failure over success as an option. This is especially so when they feel empowered to take charge of their learning.

Could you share some life-deep learning tips from your own teaching that may be useful for other teachers to implement in their own classroom practices?

While textbooks present a quick and easy access to resources, it may not be the best learning tool for all students. Often, as teachers, we need to contextualize the knowledge and make correlations to relatable real-world examples so that understanding of the topic becomes palatable to all. For example, on the topic of indices, I related the learning to the spread of COVID-19 and contact tracing by demonstrating how an infected person who met with just three friends could trigger an exponential growth in infection numbers. Similarly,

I used the statistics on how much it cost China to host the 2008 Beijing Summer Olympics (USD 42 billion) vis-à-vis the 2022 Winter Olympics (USD 3 billion) to illustrate the use of standard form.

To foster deep learning, teachers are no longer just content experts or gatekeepers of information. Instead, they are enablers of students' learning, empowering them in their learning journey by creating opportunities to give them access to meaningful learning experiences and in the process, transform them into life-long learners, critical thinkers and problem solvers.

Dr Leong Swee Ling
Master Teacher (Secondary Mathematics)
Bukit Merah Secondary School

Why is it important to instill life-deep learning in our students?

The 6Cs of global competencies are character, citizenship, collaboration, communication, creativity and critical thinking. These are guiding principles for teachers who are change makers that impact students in our day-to-day teaching. However, the teaching and learning process is a complex phenomenon. How can we create meaningful learning experiences to equip our students with these competencies?

The classroom is the environment and space where we engage our students; we need to listen to and understand our students to design lessons that would be interesting, meaningful and relatable to them. We should build a rapport with students to create a conducive environment and help them to find joy in learning. We can acknowledge their efforts and celebrate their successes to encourage them to take ownership of their own learning.

How can we create an engaging life-deep learning experience?

Engage them to dive deeper, develop flexibility in thinking and take a healthy amount of risk. Programmes such as problem-based learning, inquiry-based learning, interdisciplinary learning, creative problem solving, design thinking and computational thinking have the potential to invite our students to learn deeper. Teachers can integrate thinking tools such as "see, think, wonder" into their lessons to not only make thinking visible but also promote thinking as a way of life.

Another method to build knowledge, skills and self-confidence is to connect learning to "real-world" examples, such as finding connections with and between the learner, their family, and their communities. This helps students to deepen their connections with others while engaging in meaningful activities. Teachers are no longer in front, but rather beside them guiding them in the learning process. With the advances in technology, we have many tools to excite our students, encourage independent learning and collaboration and increase mentorship by teachers, peers and the larger community.

We can consider research-based teaching methods such as:

- using multiple and varied representatives of concepts and tasks such as diagrams, mathematical representations, simulations, multi-modal representations;
- encouraging elaboration, questioning, reasoning and communication;
- engaging learners in challenging tasks with opportunities to reflect on their own learning;
- priming student motivation by connecting topics to students' personal lives and interest, engaging students in collaborative problem solving;
- using formative assessment with clear learning intentions and success criteria, monitoring and provide feedback and include self and peer assessment

(National Research Council, 2012. Education for Life and Work: Developing transferable Knowledge and Skills in the 21st Century).

Teachers should create learning driven by curiosity and creativity through learning experiences that are meaningful, authentic, relevant and promote metacognition. Teach students to be problem designers and to pose problems, instead of just solving problems. Believe that our students want to learn and that they can learn. Together we can learn and dive deeper in our quest for skills, knowledge and values that could make a difference to our lives and those around us.

Adapting to the Problems of Tomorrow

We often hear the saying that "the only constant in life is change", but how can we adapt to these changes effectively? We speak to NIE Assistant Professor Choy Ban Heng, from the Mathematics & Mathematics Education Academic Group, whose research interests are centered around the problem of how Math teachers can develop their adaptive expertise, a key aspect of life-deep learning, in teaching.

What is life-deep learning and why is it important?

There are two key characteristics of life-deep learning.

First, it is the type of learning that matters in our lives. The only constant in life is change and no one knows what the future holds. Hence, the solution is not about learning about a lot of stuff, but rather about learning the "right" stuff. But what counts as "right"? It is about learning how to *learn*, *unlearn*, and *relearn*. In other words, we need to be adaptive.

Second, it is about deep learning and not surface learning. Often learning is associated with knowing the information. Particularly in this age of *Google*, when information is often readily available, there is a tendency to equate learning with the ability to search for information. But deep learning involves more than knowing: it involves knowing what and why; it involves making connections and applying concepts to new situations; and it involves thinking about what is known to come up with new ideas. Deep learning is important if we want our learners to solve the problems of tomorrow.

When we put these two ideas together, I see life-deep learning as the kind of learning that provides opportunities for learners to make sense of and develop a strong conceptual understanding of disciplinary ideas while being adaptive enough to see how these ideas can be applied to new problems in an ever-changing situation.

Could you share with us more about your work on adaptive expertise?

As part of adaptive expertise, teacher noticing is the study of what and how teachers notice about and learn from their own teaching—what they see and how they make sense of instructional events for the purpose of making instructional decisions.

In our first project, we observed the thinking and teaching processes of experienced and competent Math teachers. The findings provided insights into what teachers noticed about their students'

thinking and the affordances of tasks they used. This helped us to understand how teachers can develop this form of adaptive expertise.

In a follow-up project, we considered how this form of adaptive expertise could be developed through a focus on pedagogical reasoning about the instructional decisions made during day-to-day teaching activities.

This notion of learning from our daily teaching activities is important because it positions "learning from teaching" as a life-long endeavour and not just a one-time professional development session.

What outcomes or changes did you see from these projects?

The teachers in our projects realized that there were always opportunities to learn from our everyday teaching activities. I think the idea of "by teaching, we learn" is an important one for teachers to grasp. We can learn more about teaching when we plan, enact, and reflect about the lessons. Having deep adaptive expertise in teaching doesn't mean we must always look to high-technological solutions or state-of-the-art methods to solve the "ever-green problems" in education; instead, having deep adaptive expertise in teaching means that we are able to look more deeply into these problems and notice new possibilities in how we can teach differently. Often these opportunities are found in the "small things" we do each day! It is a mindset that looks for solutions to problems (both old and new) in everything we do.

How can teachers instill a sense of life-deep learning in their students?

Teachers can model that passion for life-deep learning through the way they teach. From my own teaching experiences and interactions with teachers and students, what remains years after the lessons were conducted is not the content taught or delivered. Rather, it is the sense of purpose and passion displayed during the lessons that remained with students. Students remember us for the passion we have for our subjects, the passion for learning, and the care we had for them. So, certainly, how the teacher interacts with the students is critical for instilling a sense of life-deep learning. Just as we expect our learners to learn how to learn, unlearn, and relearn, our teachers will need to do the same so that they can model the same productive mindsets necessary for the future.

Where do you see the future of life-deep learning headed toward?

If we can find an appropriate balance point between developing a deep disciplinary understanding while nurturing a productive growth mindset of seeing possibilities, we can move towards the vision of life-deep learning. The problems of the future require different experts with deep disciplinary understanding to collaborate and notice new possibilities. It is unlikely that we can have many "Da Vinci"s or universalists in our midst. But it is more likely for us to have one "Einstein", one "Steve Jobs", and one "Van Gogh" to come together and work on solving the problems of the future. What is needed will then be for the experts to be open to learning and seeing new possibilities while being firmly anchored in their area of expertise.

ABOUT THE INTERVIEWEE

Choy Ban Heng is Assistant Professor with the Mathematics & Mathematics Education Academic Group at NIE. His research interests center on helping Math teachers to develop their adaptive expertise in teaching by enhancing their productive teacher noticing during professional learning opportunities and teacher education.

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